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APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
10/050,417	01/16/2002	Khoi A. Phan	G0131	6101

7590 10/23/2003

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EXAMINER	
RUGGLES, JOHN S	

ART UNIT	PAPER NUMBER
1756	

DATE MAILED: 10/23/2003

Please find below and/or attached an Office communication concerning this application or proceeding.

Office Action Summary	Application No.	Applicant(s)	
	10/050,417	PHAN ET AL.	
	Examiner	Art Unit	
	John Ruggles	1756	

-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address --

Period for Reply

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE 3 MONTH(S) FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If the period for reply specified above is less than thirty (30) days, a reply within the statutory minimum of thirty (30) days will be considered timely.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133).
- Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

Status

1)☒ Responsive to communication(s) filed on *29 September 2003* .

2a)☒ This action is **FINAL**. 2b)☐ This action is non-final.

3)☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

Disposition of Claims

4)☒ Claim(s) *1,7-18,22 and 23* is/are pending in the application.

4a) Of the above claim(s) _____ is/are withdrawn from consideration.

5)☒ Claim(s) *1,7-18 and 22* is/are allowed.

6)☒ Claim(s) *23* is/are rejected.

7)☐ Claim(s) _____ is/are objected to.

8)☐ Claim(s) _____ are subject to restriction and/or election requirement.

Application Papers

9)☐ The specification is objected to by the Examiner.

10)☒ The drawing(s) filed on *29 September 2003* is/are: a)☒ accepted or b)☐ objected to by the Examiner.

Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).

11)☐ The proposed drawing correction filed on _____ is: a)☐ approved b)☐ disapproved by the Examiner.

If approved, corrected drawings are required in reply to this Office action.

12)☐ The oath or declaration is objected to by the Examiner.

Priority under 35 U.S.C. §§ 119 and 120

13)☐ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).

a)☐ All b)☐ Some * c)☐ None of:

1.☐ Certified copies of the priority documents have been received.

2.☐ Certified copies of the priority documents have been received in Application No. _____ .

3.☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).

* See the attached detailed Office action for a list of the certified copies not received.

14)☒ Acknowledgment is made of a claim for domestic priority under 35 U.S.C. § 119(e) (to a provisional application).

a) ☐ The translation of the foreign language provisional application has been received.

15)☐ Acknowledgment is made of a claim for domestic priority under 35 U.S.C. §§ 120 and/or 121.

Attachment(s)

1) ☐ Notice of References Cited (PTO-892)
2) ☐ Notice of Draftsperson's Patent Drawing Review (PTO-948)
3) ☐ Information Disclosure Statement(s) (PTO-1449) Paper No(s) _____ .
4) ☐ Interview Summary (PTO-413) Paper No(s). _____ .
5) ☐ Notice of Informal Patent Application (PTO-152)
6) ☐ Other: .

DETAILED ACTION

Drawings

In response to the previous Office action mailed 27 June 2003, the amended Figures 1-2, 5A-5B, and 6B filed 29 September 2003 have overcome the previous objections to these drawings. Accordingly, these previous objections to the drawings are now withdrawn.

Specification

The previous objections to the specification have also been overcome by amendment and are now withdrawn.

Claim Objections

The previous objections to original claims 8, 12, 14, and 18 have been overcome by amendments to these claims, so these previous objections are now withdrawn.

Claim Rejections - 35 USC § 112

The previous rejections of original claims 2-12, 17-19, and 22 under the second paragraph of 35 U.S.C. 112 have been overcome because (1) original claims 2-6 and 19-21 have been cancelled and (2) claims 7-8, 11-12, 17-18, and 22 have been amended. Amended claim 7 now depends on amended claim 1. Accordingly, these previous rejections are now withdrawn.

Claim Rejections - 35 USC § 102

The previous rejection of original claims 1-3 and 19 under 35 U.S.C. 102(b) as being anticipated by Palmer (US Patent 4,768,291) has been overcome by amending claim 1 and canceling claims 2-3 and 19. Therefore, this previous rejection is now withdrawn.

Claim Rejections - 35 USC § 103

The following is a quotation of 35 U.S.C. 103(a) which forms the basis for all obviousness rejections set forth in this Office action:

> (a) A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102 of this title, if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains. Patentability shall not be negatived by the manner in which the invention was made.

Claim 23 is rejected under 35 U.S.C. 103(a) as being unpatentable over Palmer (US Patent 4,768,291) in view of Peterson, et al. (US Patent 5,429,673), further in view of Erhardt, et al. ("*An Investigation of Circular Resist Residue Defects in the Development of a 0.16μm Flash Process*", cited as prior art in applicant's IDS of Paper #2, filed 04 April 2002), further in view of Ebersole (US Patent 5,324,620), and further in view of Orth (US Patent 5,750,317).

Palmer teaches a method and apparatus for processing a semiconductor wafer. The process reduces defect density (especially those resulting from unwanted residue) and promoting adhesion of photoresist by baking and liquid or vapor hexamethyldisilizane (HMDS) priming a semiconductor substrate before coating with photoresist (column 1, lines 32-38). After imagewise exposure of the photoresist and developing to remove the exposed portion of the photoresist, additional silylation of the imaged photoresist by HMDS at a vapor pressure of 6-

500 Torr enhances resistance to plasma etching (column 3, lines 18-44). Removal of the exposed photoresist is understood to include resist residues, since Palmer points out the necessity of particular handling techniques to ensure that no residue of processing liquid be left on the wafer in wet processing steps at column 2, lines 53-56. The HMDS priming is carried out at any one of various pressures (e.g., 6 Torr, 200 Torr, etc.). The vapor pressure of HMDS varies with temperature as shown in Figure 4. An HMDS vapor pressure of 200 Torr corresponds to a temperature of more than 70°C (roughly 85°C) and that of 500 Torr roughly corresponds to 130°C (column 4, lines 1-10). At column 4, lines 2-5, Palmer states there is evidence that the priming process would be carried out faster and perhaps more effectively at a higher pressure (higher concentration of HMDS). This indicates that the HMDS vapor priming could be performed at a low temperature in a relatively short time.

While teaching HMDS vapor priming at a temperature in a range that fully encompasses about 85°C to about 130°C and even indicating that it would be advantageous to perform the priming in a relatively short time, Palmer does not specify the relatively short time to be about 5 seconds to about 20 seconds.

Peterson shows silylation by HMDS vapor priming the surface of a semiconductor substrate at a temperature of about 25°C to about 200°C (column 6, lines 1-11) and gives examples of HMDS vapor priming at the following specific temperatures and times: (Example 2) 50°C for 20, 40, and 60 seconds; (Example 3) 60°C for 30 seconds; and (Example 4) 100°C for 10 seconds (column 7, lines 18-60). HMDS vapor priming of a semiconductor wafer improves adhesion of subsequently applied photoresist and can repel polar groups such as water and aqueous developers (column 1, lines 46-65).

It would have been obvious to one of ordinary skill in the art at the time the invention was made to have combined the HMDS vapor priming at about 85°C to about 130°C for a relatively short time as taught by Palmer with the relatively short time for this HMDS vapor priming of about 10 seconds (for 100°C) to about 60 seconds (for 50°C). This is because both references teach the same type of treatment (HMDS vapor priming of a semiconductor substrate) for the same and/or similar reason (to improve adhesion of photoresist and/or repel unwanted residue). Furthermore, extrapolating this time trend shown by the Peterson examples for the HMDS treatment within the temperature range shown by Palmer to about 130°C would be expected to reduce the needed treatment time to less than 10 seconds (e.g., to about 5 seconds, etc.).

Palmer and Peterson do not specifically teach maintaining a high exhaust air velocity during spin developing.

Erhardt describes techniques for reducing resist residue defects in semiconductor device manufacture. In reference to Figure 7 on page 4 of 6, reduction in developing spin speed minimizes the amount of splashing inside the developer cup and consequently reduces formation of developer droplets containing resist residue. Also shown in Figure 7, increasing cup exhaust reduces the amount of resist byproducts carried by these droplets surrounding the wafer (found in the second full paragraph in the first column on page 5 of 6). This is understood to mean that a high exhaust air velocity during developing would reduce defects by carrying the resist residue droplets away from the spinning wafer before they could redeposit on the wafer. It is also suggested that resist residue can be minimized by extending rinsing cycle(s) after developing (second full paragraph in the first column on page 4 of 6). The overall photolithography process

can be fine-tuned to minimize defects through a combination of reduced generation and enhanced removal (third full paragraph in the first column on page 5 of 6).

It would have been obvious to one of ordinary skill in the art at the time the invention was made to have modified the process as taught by Palmer and Peterson by increasing cup exhaust air velocity to a high rate during developing to carry away developer droplets containing resist residue and prevent their redeposition on the semiconductor wafer, with the expectation of reducing resist residue defects as described by Erhardt.

Palmer, Peterson, and Erhardt do not teach rinsing front and back sides of the resist coated semiconductor substrate in separate steps while spinning at a medium and a low speed, followed by further washing of the front side before drying while spinning at a high speed.

Ebersole discloses a radiation sensitive composition (resist) and a method of using this resist for making circuits by coating the resist on a semiconductor wafer, imaging, and developing the resist to form a desired pattern. The developing was carried out in a spray developing spinner by (1) dispensing the developer for 3 seconds while spinning the substrate at 500 RPM, (2) holding for 60 seconds, (3) rinsing for 20 seconds with deionized water at 1,000 RPM, and (4) drying for 10 seconds at 5,000 RPM (column 23, lines 32-36). The medium speed rinsing is understood to include removing both developer and resist residues from both front and back sides of the wafer before drying by spinning at high speed. Increasing the spinning speed necessarily involves acceleration, but the rate of this acceleration is not specified.

Orth teaches a process of removing undesired resist residue (e.g., edge beads, etc.) which cause defects on a semiconductor wafer by solvent washing while spinning the wafer. This preferably includes dispensing the solvent at the back of the wafer, allowing centrifugal force to

spread the solvent to the edge of the wafer (column 6, lines 7-11). The solvent is dispensed for approximately 10 seconds while spinning the wafer at a low speed of approximately 250-500 RPM (column 6, lines 54-55). This is followed by further dispensing of solvent while ramping up the speed over a 5 second interval to a high speed of 3,000 RPM or higher (up to at least approximately 4,000 RPM or higher, column 6, lines 23-27 and 50-52). This represents an average acceleration of about 500-950 RPM per second, which reads on a low acceleration of about 1,000 RPM per second for a top high speed of about 3,000-5,000 RPM. The wafer is spun at the high speed for an additional 15 seconds and then dried at 1,500 RPM (column 6, lines 33-41).

It would have been obvious to one of ordinary skill in the art at the time the invention was made to have modified the process as taught by Palmer, Peterson, and Erhardt to incorporate medium speed rinsing and low speed rinsing as disclosed by Ebersole and taught by Orth as well as high speed drying as disclosed by Ebersole and taught by Orth. This is because all these references relate to the same art of removing resist residue from semiconductor substrates. In fact, Erhardt specifically states the advantages of using lower developer spinning speed to reduce splashing (reduced generation of residues) and increasing the number and/or length of rinsing cycle(s) after developing (enhanced removal of residues) in order to reduce resist residue defects. This is understood to include plural separate medium and low spinning speed rinsing steps of both front and back of the spinning substrate, with the expectation that reducing the spinning speed during the second or subsequent rinsing will create less splashing and generate less resist residues which cause defects. Once the residues are removed by this sequence of rinsing steps, splashing during drying is not likely to result in any defects. Therefore, high speed spinning

during drying would be expected to reduce overall processing time without generating additional resist residue defects (instant claim 23). Likewise, it would also have been obvious to have doubled (from 20 to 40 seconds) the length of the medium speed 1,000 RPM rinsing step of Ebersole based on the suggestion of Erhardt that increasing the length of rinsing cycle(s) would enhance removal of resist residues. During fine tuning of the rinsing process as described by Erhardt, the low speed solvent rinsing step at approximately 500 RPM for approximately 10 seconds of Orth approaches and reads on the instant low speed rinsing at about 600 RPM for about 8 seconds. Additionally, the 5-second interval of solvent dispensing as taught by Orth during ramping up the spinning speed is substantially equivalent to the instant third time period for rinsing of about 5 seconds.

Allowable Subject Matter

Claims 1, 7-18, and 22 are allowed.

The following is a statement of reasons for the indication of allowable subject matter: while the concept of using a high exhaust air velocity during spin developing of an imaged resist on a semiconductor substrate is not new (for the reasons discussed above), the specific exhaust air velocity range of about 5 meters per second to about 6 meters per second of instant claims 1, 7-18, and 22 are distinguished over the prior art, which does not teach this specific range for exhaust air velocity during spin developing.

Response to Arguments

Amended claims 1, 7-18, and 22 are now allowed for the reasons stated above.

However, applicants' arguments with respect to claim 23 have been fully considered, but they are not deemed persuasive.

In response to applicant's argument on page 13 of the amendment filed 29 September 2003 that the examiner has combined an excessive number of references, reliance on a large number of references in a rejection does not, without more, weigh against the obviousness of the claimed invention. See *In re Gorman*, 933 F.2d 982, 18 USPQ2d 1885 (Fed. Cir. 1991).

Applicants also argue on page 13 of this amendment that claim 23 is not obvious over the cited prior art of record by alleging that Ebersole's use of a vacuum chuck makes it impossible to rinse the backside of the wafer. While use of a vacuum support chuck would be expected to prevent a portion of the backside of the wafer (usually at the center portion, where it is attached to the chuck) from contact with a spray developer or rinsing agent, such a vacuum chuck would ***not*** be expected to make ***all*** rinsing of the backside impossible. Further, this argument is completely silent with regard to the contributions of Orth. Orth teaches preferably dispensing a solvent at the ***back*** of a spinning wafer to wash away resist residue defects (column 6, lines 7-11). Both of these references were previously cited in the rejection of claim 23 and have been restated, as necessitated by applicants' amendment. Therefore, the previous rejection of claim 23 still stands and is now made **FINAL**.

All other previous objections and rejections have been withdrawn as being overcome by applicants' amendment, as noted above.

Conclusion

THIS ACTION IS MADE FINAL. Applicant is reminded of the extension of time policy as set forth in 37 CFR 1.136(a).

A shortened statutory period for reply to this final action is set to expire THREE MONTHS from the mailing date of this action. In the event a first reply is filed within TWO MONTHS of the mailing date of this final action and the advisory action is not mailed until after the end of the THREE-MONTH shortened statutory period, then the shortened statutory period will expire on the date the advisory action is mailed, and any extension fee pursuant to 37 CFR 1.136(a) will be calculated from the mailing date of the advisory action. In no event, however, will the statutory period for reply expire later than SIX MONTHS from the mailing date of this final action.

Any inquiry concerning this communication or earlier communications from the examiner should be directed to John Ruggles whose telephone number is 703-305-7035. The examiner can normally be reached on Monday-Thursday and alternate Fridays.

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Mark Huff can be reached on 703-308-2464. The fax phone number for the organization where this application or proceeding is assigned is (703) 872-9306.

Any inquiry of a general nature or relating to the status of this application or proceeding should be directed to the receptionist whose telephone number is 703-308-0661.

John Ruggles
Examiner
Art Unit 1756

MARK F. HUFF
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TECHNOLOGY CENTER 1700